Journal of Acute Medicine 12(3): 105-112, 2022
DOI:10.6705/j.jacme.202209_12(3).0003
Original Article

Impact of COVID-19 Pandemic on Emergency Department Volume and Acuity in Low Incidence Area: Taiwan's Experience in Three Hospitals

Pei-Hsien Lin[1], Hung-Yuan Su[1,2], I-Ting Tsai[1,3], Kuo-Hsin Lee[1,2], Yu-Han Wang[1,4], Chao-Sheng Chang[1,5], Meng-Chun Hsu[6], Jeng-Long Tsai[1,*], Chih-Wei Hsu[1,7,*]

[1]Department of Emergency Medicine, E-Da Hospital and I-Shou University, Kaohsiung, Taiwan
[2]School of Chinese Medicine for Post Baccalaureate, I-Shou University, Kaohsiung, Taiwan
[3]School of Medicine, I-Shou University, Kaohsiung, Taiwan
[4]Center of Quality Management, E-Da Hospital, Kaohsiung, Taiwan
[5]Department of Occupational Therapy, I-Shou University, Kaohsiung, Taiwan
[6]National Pingtung Girls' Senior High School, Pingtung, Taiwan
[7]School of Medicine for International Students, I-Shou University, Kaohsiung, Taiwan

Background: The decrease in emergency department (ED) patient visits during the COVID-19 pandemic was reported by various studies. Our study aimed to investigate whether a similar trend can be observed in a country with a low incidence of COVID-19 as well as the impact caused by the pandemic on ED patients in different triage levels and categories.
Methods: This multicenter retrospective study collected data from three regional hospitals between March 2019 and December 2020. We evaluated the differences between patient volume, disease severity, and patient composition in ED before and after the COVID-19 pandemic among these hospitals.
Results: There was a 23% reduction in ED patient volume in the urban hospital (hospital A) as well as a 16% reduction in suburban hospitals (hospitals B and C) during the pandemic period, respectively. The regression analysis showed a high correlation in the change in monthly patient volume among these hospitals. In terms of severity, there was a 24% reduction in ED visits with high severity levels (Taiwan Triage and Acuity Scale [TTAS] I, II) in hospital A, as well as 16% and 12% in hospitals B and C during the pandemic period, respectively. Similarly, there was a 23% reduction in ED visits with low severity levels (TTAS III, IV, V) in hospital A, as well as 20% and 16% in hospitals B and C during the pandemic period, respectively. In terms of patient types, there was a significant decline in non-traumatic adult patients (19%, 17%, and 10%), and pediatric patients (49%, 50%, and 46%) in hospitals A, B, and C, respectively.
Conclusions: Despite the low incidence of COVID-19 in Taiwan, a decrease in total ED visits was still found during the pandemic, especially in non-trauma adult visits and pediatric visits. In addition, ED visits in both high and low severity levels decreased in these regional hospitals.

Key words: *COVID-19 pandemic, Taiwan Triage and Acuity Scale, emergency department visits*

Received: August 2, 2021; Revised: October 8, 2021; Accepted: November 12, 2021.
*Corresponding author: Chih-Wei Hsu, MD, PhD, Department of Emergency Medicine, E-Da Hospital and I-Shou University, No. 1, Yida Rd., Yanchao Dist., Kaohsiung City 824005, Taiwan. E-mail: saab30002000@gmail.com; Jeng-Long Tsai, MD, Department of Emergency Medicine, E-Da Hospital and I-Shou University, No. 1, Yida Rd., Yanchao Dist., Kaohsiung City 824005, Taiwan. E-mail: noyu.tw@yahoo.com.tw

Introduction

Since the first case infected by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was reported in Wuhan, China in December, 2019,[1-4] and the coronavirus disease 2019 (COVID-19) pandemic was declared by the World Health Organization (WHO) in March, 2020,[5] relevant governmental response actions, including quarantines, stay-at-home orders, and city lockdowns, have been taken to prevent further viral transmission. These governmental policies along with the public fear of SARS-CoV-2 infection have affected individuals' will to visit a hospital, which in turn caused a major impact on healthcare systems worldwide.[6] Meanwhile, various alternative methods, such as telemedicine, remote monitoring, video conference, or phone tracking, have been developed rapidly to replace traditional hospital visits.[7,8] As a result, several studies from various countries have demonstrated obvious reductions in the emergency department (ED) patient volumes during the COVID-19 pandemic.[9-15]

Although published literature has reported the change in ED patient volumes and found a significant difference in the composition of ED visits (i.e., non-trauma adult, trauma, or pediatrics) and disease severity (i.e., triage levels I–V) before and after the COVID-19 pandemic,[9-15] most of the studies were conducted in the early period of COVID-19 pandemic between January and May in 2020, and in areas with a high incidence of COVID-19.[9-13] Our study aimed to investigate whether a similar trend and characteristics of reduction in ED patient visits could be observed in Taiwan, where did not have a new local case of COVID-19 diagnosed after April 12 during the study period.

Methods

Study Design and Patient Population

This multicenter retrospective study was conducted using the data collected from the administrative boards of EDs in three regional hospitals in southern Taiwan that has a capacity of around 800 to 1,365 beds and 40,000 to 80,000 emergency visits per year. Ditmanson Medical Foundation Chia-Yi Christian Hospital, located in an urban area, was represented by hospital A. Dalin Tzu Chi Hospital and E-DA Hospital, both located in suburban areas, were represented by hospitals B and C, respectively. Data were obtained through the administrative boards as part of the institutional operations and quality improvement. Ethics approval for this study was granted by the Institutional Review Board of the E-DA Hospital (EMRP-110-078). The need for informed consents was waived because of the retrospective nature of the present study.

The data were collected from March 2019 to December 2020. The start of COVID-19 pandemic was defined as the announcement made by WHO in March 2020. We compared the differences between the ED visits in COVID-19 pandemic from March to December in 2020 and the corresponding pre-pandemic period from March to December in 2019. We evaluated the differences in terms of total ED patient volume, triage levels, and composition of ED visits before and after COVID-19 pandemic among these hospitals.

Study Parameter and Definition

The EDs in these three hospitals all comprised non-trauma adult unit, trauma unit, and non-trauma pediatric unit. A patient over 18 years of age was defined as an adult. Obstetric and gynecologic ED visits were excluded because of the small patient volume. Taiwan Triage and Acuity Scale (TTAS), which was a five-level scale used for disease urgency assessment in the present study, is a modification of the Canadian Triage and Acuity Scale. Apart from the chief complaints, TTAS also takes vital signs, level of consciousness, pain severity, and the mechanism of trauma into account. There are five levels of urgency: level I, resuscitation; level II, emergency; level III, urgent; level IV, less urgent; and level V, non-urgent.[16]

Statistical Analysis

All data were analyzed by using SPSS version 22 (SPSS Inc, Chicago, IL). Student's *t*-test was used for determining the significance of difference among continuous variables. A two-tailed p value of less than 0.05 was considered statistically significant. Furthermore, the trends of total ED patient volume in these three hospitals were analyzed by using Pearson's correlation coefficient, ranging from –1 to 1, to assess the correlation between each paired group.

Results

The change of monthly ED volumes from March to December in 2020 was demonstrated (Fig. 1). The trend of change in ED patient volume started from March and lasted till September, followed by a slight

return to a level more similar to 2019 after October 2020 in all three hospitals (Fig. 1). There was a 23% decrease in total ED volume in the urban hospital (hospital A), as well as 16% decreases in both suburban hospitals (hospitals B and C) during COVID-19 pandemic, and all of which reached statistical significance (p value < 0.001) (Table 1). In addition, the trend of monthly ED volume during COVID-19 pandemic showed a high correlation (R from 0.805 to 0.949) among the three hospitals (Fig. 2).

A significant decrease in ED patient volume during the COVID-19 pandemic was observed across all triage levels in the three hospitals (Table 2). In high disease severity (triage levels I and II), significant decreases in patient volume were observed in hospitals A, B, and C (24%, 16%, and 12%, respectively). Likewise, significant decreases in patient volume of low disease severity (triage levels III–V) were also observed in hospitals A, B, and C (23%, 20%, and 16%, respectively). Additionally, ED visits of low disease severity reduced more than those of high disease severity in suburban hospitals during COVID-19 pandemic (20% vs. 16% in hospital B and 16% vs. 12% in hospital C).

As for composition of ED patients, the ED pediatric visits during the COVID-19 pandemic had dramatically decreased in hospitals A, B, and C (49%, 50%, and 46%, respectively, all p value < 0.001) (Table 3). Similarly, in terms of non-trauma adult visits, significant decreases in ED patient visits were also observed in all hospitals (19%, 17%, and 10%, respectively, all p value < 0.001). Nevertheless, the rates of decreases for trauma visits in the three hospitals were 6%, 7%, and 6% during COVID-19 pandemic, respectively, which had no statistical significance (p value = 0.18, 0.054, and 0.073, respectively).

Discussion

In the present study, our findings are consistent with other studies conducted in countries with high incidence of COVID-19,[9-13] revealing that despite the low incidence of COVID-19, there has been a similar pattern of decrease in volume either in total ED visits or in specific types of ED visits in Taiwan. A previous study in northern Taiwan has shown that there was a 33.45% decrease in ED visits during the pandemic, which was more significant than our report

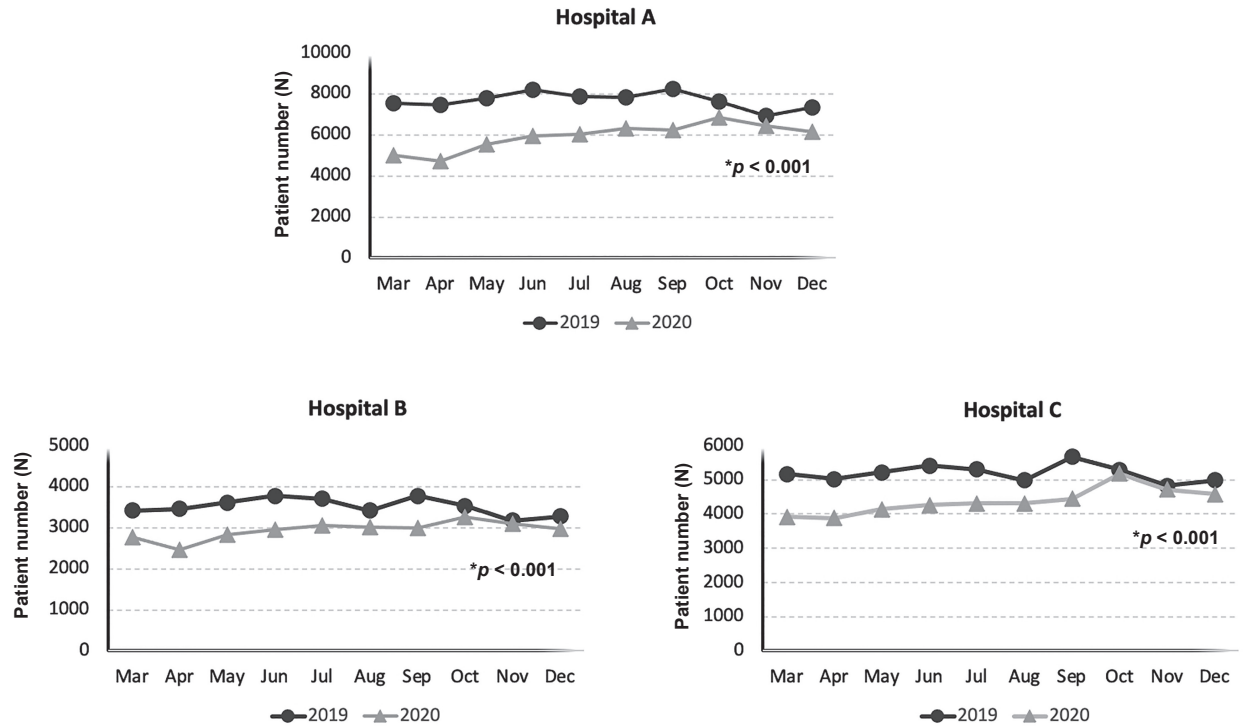


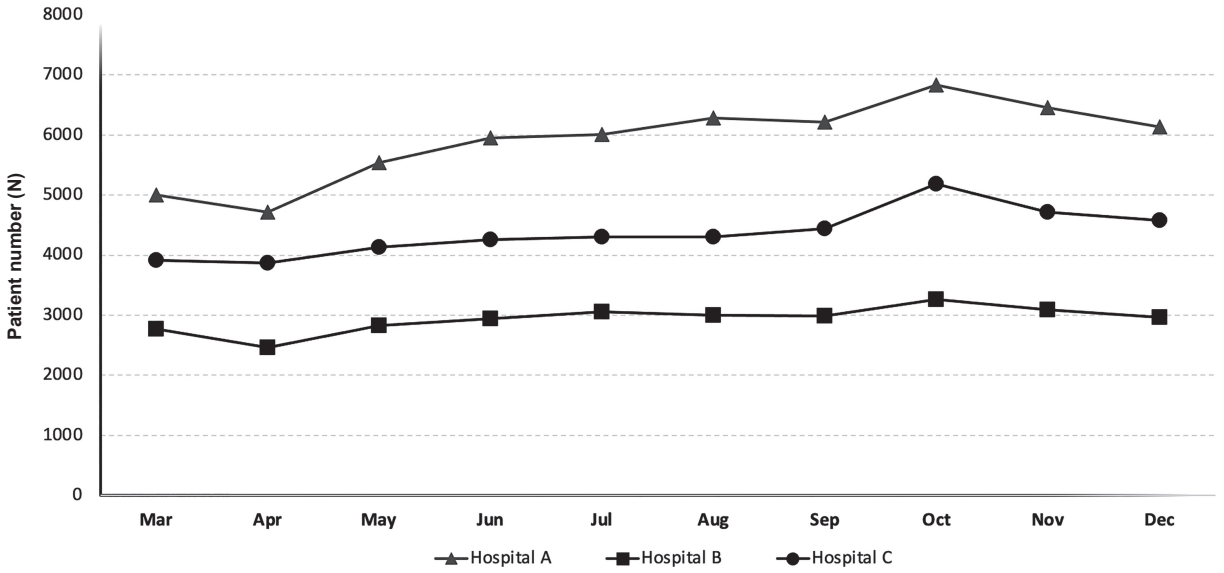
Fig. 1. Variabilities of monthly emergency department patient volumes before and after COVID-19 pandemic in three hospitals.

*p value < 0.05.

Table 1. Comparison of total ED volumes before and after COVID-19 pandemic

Group	Pre-pandemic ED visitsa	Pandemic ED visitsb	Decreased rate (%)	*p* value
Hospital A	76,890	59,162	23	< 0.001*
Hospital B	35,141	29,393	16	< 0.001*
Hospital C	51,879	43,706	16	< 0.001*

[a]Pre-pandemic period defined from March to December in 2019.
[b]Pandemic period defined from March to December in 2020.
*p value < 0.05 is considered statistically significant.
ED: emergency department.



	Hospital B		Hospital C	
	R	*p* value	R	*p* value
Hospital A	0.949	< 0.001	0.905	< 0.001*
Hospital B			0.863	0.001*

Fig. 2. Comparing the trend of monthly emergency department patient volumes during the period of COVID-19 pandemic and the associated correlation between three hospitals.
*p value < 0.05.

(16%–23%), but the study only collected data in one northern medical center, and it was investigated in the very early phase of COVID-19 pandemic as well as only between the short period of February and April in 2020.[15] In current study, we enrolled three different regional hospitals as well as a more extended study period, disclosing that the impact of COVID-19 pandemic on ED visits has sustained until September 2020, and it was not until after October 2020 that the ED volumes eventually returned closer to the usual of 2019. Our study also demonstrated that the correlational trend of changes in ED volumes occurred among all enrolled hospitals. Even though there was no new local case of COVID-19 diagnosed after April 12 in Taiwan, the trend of decline in ED volumes persisted until October 2020. This phenomenon indicated that the concern for SARS-CoV-2 infection, which consequently resulted in the avoidance of ED visits, might not have only been affected by the local spread of COVID-19, but also by the global pandemic.[15] Fur-

Table 2. Comparison of patient volumes with different triage level before and after COVID-19 epidemic

Group	High triage level (I, II)				Low triage level (III, IV, V)			
	Pre-pandemic ED visits[a] (%)	Pandemic ED visits[b] (%)	Decreased rate (%)	*p* value	Pre-pandemic ED visits (%)	Pandemic ED visits (%)	Decreased rate (%)	*p* value
Hospital A	14,598 (19.0)	11,040 (18.7)	24	< 0.001*	62,295 (81.0)	48,111 (81.3)	23	< 0.001*
Hospital B	6,987 (19.9)	5,897 (20.7)	16	< 0.001*	28,153 (80.1)	22,596 (79.3)	20	< 0.001*
Hospital C	7,652 (14.7)	6,772 (15.5)	12	< 0.001*	44,227 (85.3)	36,934 (84.5)	16	< 0.001*

[a]Pre-pandemic period defined from March to December in 2019.
[b]Pandemic period defined from March to December in 2020.
*p value < 0.05 is considered statistically significant.
ED: emergency department.

thermore, the corresponding containment measures to COVID-19 pandemic by the Taiwanese Ministry of Health and Welfare during this period also contributed to the decline of ED volume.[14]

This is the first study to assess the impact on ED visits in different regional hospitals during COVID-19 pandemic. There was a disproportional decrease in the hospital located in an urban area (23% decrease in hospital A) compared with those two in suburban areas (both 16% decreases). Around 79%–85% of ED visits were composed of low triage levels (levels III–V) (Table 2). Therefore, the decreased ED visits of low triage levels might contribute majorly to the total ED volumes. A national retrospective study in Taiwan demonstrated patients living in urbanized areas had a higher propensity for non-emergent ED visits.[17] Thus, the concern for COVID-19 might drastically reduce the non-emergent ED visits during COVID-19 pandemic[6,9] and cause the disproportional decrease in ED patients in hospitals located in urban areas. Indeed, hospital A had a higher rate of decrease than hospitals B and C (23% vs. 20% and 16%, respectively) in low triage levels.

In addition to ED patient volume, the disease severity of ED visits was another issue related to ED overcrowding and resource utilization.[18] Although the alternative behavior in seeking health care during COVID-19 pandemic because of the fear of getting infected by a novel virus could be predicted,[6,9] ED patients with high severity disease was not expected to decrease because of the high requirement for ED medical resources in this group. However, the phenomenon was not observed in the present study. Regardless of disease severity, decreases in ED patient volume in both high and low triage levels were observed. The rates of decrease in ED visits of high triage levels demonstrated 24%, 16%, and 12% in hospitals A, B, and C, respectively. We deduced a few possible explanations for the decline of ED visits in high triage levels. First, emergency medical service administrators might prefer transferring critical patients to medical centers rather than regional hospitals because of the fact that more medical capacity and resources are available in the former option.[12] Indeed, studies in two medical centers in Taiwan also revealed no significant decrease in critical patients in ED visits.[15,19] Second, wearing masks, handwashing, and social distancing could contribute to reduced incidence of some infectious diseases, such as influenza and enterovirus infection, or all-cause of pneumonia, which might reduce ED visits of both high and low disease severity.[20] Third,

Table 3. Comparison of patient volumes among different composition of ED visits before and after COVID-19 pandemic

Group	Adult, non-trauma				Trauma			
	Pre-pandemic ED visits[a]	Pandemic ED visits[b]	Decreased rate (%)	*p* value	Pre-pandemic ED visits	Pandemic ED visits	Decreased rate (%)	*p* value
Hospital A	45,930	37,127	19	< 0.001*	13,961	13,119	6	0.180
Hospital B	25,260	21,081	17	< 0.001*	6,310	5,892	7	0.054
Hospital C	30,338	27,194	10	0.001*	12,020	11,318	6	0.073

Group	Pediatrics, non-trauma			
	Pre-pandemic ED visits	Pandemic ED visits	Decreased rate (%)	*p* value
Hospital A	16,625	8,451	49	< 0.001*
Hospital B	2,740	1,367	50	< 0.001*
Hospital C	9,188	4,996	46	< 0.001*

[a]Pre-pandemic period defined from March to December in 2019.
[b]Pandemic period defined from March to December in 2020.
*p value < 0.05 is considered statistically significant.
ED: emergency department.

the assessment of triage levels according to triage and acuity scale could not fully represent the severity and complexity of patients' diseases.[18,21]

In terms of composition of ED visits, all hospitals uniformly showed significant declines in non-trauma adult patients and pediatric patients. Interestingly, the pediatric ED visits showed a greatly disproportional decline around 50% in all three hospitals, which was also observed in other studies.[9,11,15] The public health policies for COVID-19 may have inadvertently prevented the spread of various infectious diseases, such as enterovirus infection or respiratory disease, in pediatric and adult patients.[11,20] Conversely, trauma cases in the ED showed no obvious decrease during the COVID-19 pandemic. An observational study in Italy demonstrated decline in trauma ED visits during the COVID-19 pandemic because of restrictions on outdoor activities, such as curfews, which might in turn reduce injury-related visits to ED.[11] However, the significant decrease in trauma ED visits was not observed in our study partly owing to the fact that containment measures were not performed in Taiwan because of our low incidence of COVID-19.

During the pandemic, the arrangement of manpower in ED was crucial. Apart from regular medical tasks, multiple measures have been adopted for pandemic management and prevention in ED. Medical facilities were impacted by the pandemic, and resource management became challenging. Our study described a trend in the change of ED volume during the pandemic which can provide additional information for the rearrangement of emergency medical personnel and resources during pandemic. For instance, the sharp decline in adult and pediatric non-trauma visits may allow more emergency physician or pediatrician to work on pandemic prevention such as screening test for a possible novel virus in the future.

There are several limitations in this study. Firstly, we did not conduct detailed analysis of the specific diseases for ED patients, and the triage levels could not completely represent the disease severity. Secondly, the study was conducted at regional hospitals in Taiwan which may restrict the generalizability of our findings. Thirdly, the data were collected from March to the end of 2020, and hence the changing pattern of ED volumes could be different so long as the COVID-19 pandemic persisted. In conclusion, despite low incidence of COVID-19 in Taiwan, total ED visits still significantly dropped during the COVID-19 pandemic, and all regional hospitals enrolled in the study had a high correlation in the trend of monthly volume changes. Obvious decreases in non-trauma adult and pediatric ED visits were observed, but not in trauma visits. In addition, ED visits all decreased regardless of the disease severity level.

Conflicts of Interest Statement

There are no conflicts of interest

Acknowledgments

The authors would like to thank Ditmanson Medical Foundation Chia-Yi Christian Hospital and Dalin Tzu Chi Hospital which contributed data during the COVID-19 pandemic in 2020 to this study.

References

1. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA* 2020;323:1239-1242. doi:10.1001/jama.2020.2648
2. Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): the epidemic and the challenges. *Int J Antimicrob Agents* 2020;55:105924. doi:10.1016/j.ijantimicag.2020.105924
3. Wu YC, Chen CS, Chan YJ. The outbreak of COVID-19: an overview. *J Chin Med Assoc* 2020;83:217-220. doi:10.1097/jcma.0000000000000270
4. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomed* 2020;91:157-160. doi:10.23750/abm.v91i1.9397
5. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19—11 march 2020. Available at: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020. Accessed March 11, 2020.
6. Wong LE, Hawkins JE, Langness S, Murrell KL, Iris P, Sammann A. Where are all the patients? Addressing COVID-19 fear to encourage sick patients to seek emergency care. *NEJM Catal Innov Care Deliv* 2020. doi:10.1056/cat.20.0193
7. Wong GL, Wong VW, Thompson A, et al. Management of patients with liver derangement during the COVID-19 pandemic: an Asia-Pacific position statement. *Lancet Gastroenterol Hepatol* 2020;5:776-787. doi:10.1016/s2468-1253(20)30190-4
8. Su HY, Hsu YC. Patients with cirrhosis during the COVID-19 pandemic: current evidence and future perspectives. *World J Clin Cases* 2021;9:2951-2968. doi:10.12998/wjcc.v9.i13.2951
9. Westgard BC, Morgan MW, Vazquez-Benitez G, Erickson LO, Zwank MD. An analysis of changes in emergency department visits after a state declaration during the time of COVID-19. *Ann Emerg Med* 2020;76:595-601. doi:10.1016/j.annemergmed.2020.06.019
10. Boserup B, McKenney M, Elkbuli A. The impact of the COVID-19 pandemic on emergency department visits and patient safety in the United States. *Am J Emerg Med* 2020;38:1732-1736. doi:10.1016/j.ajem.2020.06.007
11. Mahmassani D, Tamim H, Makki M, Hitti E. The impact of COVID-19 lockdown measures on ED visits in Lebanon. *Am J Emerg Med* 2021;46:634-639. doi:10.1016/j.ajem.2020.11.067
12. Butt AA, Azad AM, Kartha AB, Masoodi NA, Bertollini R, Abou-Samra AB. Volume and acuity of emergency department visits prior to and after COVID-19. *J Emerg Med* 2020;59:730-734. doi:10.1016/j.jemermed.2020.08.013
13. Castoldi L, Solbiati M, Costantino G, Casiraghi E. Variations in volume of emergency surgeries and emergency department access at a third level hospital in Milan, Lombardy, during the COVID-19 outbreak. *BMC Emerg Med* 2021;21:59. doi:10.1186/s12873-021-00445-z
14. Tsai LH, Chien CY, Chen CB, et al. Impact of the coronavirus disease 2019 pandemic on an emergency department service: experience at the largest tertiary center in Taiwan. *Risk Manag Healthc Policy* 2021;14:771-777. doi:10.2147/rmhp.S272234
15. Lo HY, Chaou CH, Chang YC, Ng CJ, Chen SY. Prediction of emergency department volume and severity during a novel virus pandemic: experience from the COVID-19 pandemic. *Am J Emerg Med* 2021;46:303-309. doi:10.1016/j.ajem.2020.07.084
16. Ng CJ, Hsu KH, Kuan JT, et al. Comparison between Canadian Triage and Acuity Scale and Taiwan Triage System in emergency departments. *J Formos Med Assoc* 2010;109:828-837. doi:10.1016/s0929-6646(10)60128-3
17. Huang LC, Chung WF, Liu SW, Wu JC, Chen LF, Chen YC. Characteristics of non-emergent visits in emergency departments: profiles and longitudinal pattern changes in Taiwan, 2000–2010. *Int J Environ Res Public Health* 2019;16:1999. doi:10.3390/ijerph16111999
18. Hahn B, Zuckerman B, Durakovic M, Demissie S. The relationship between emergency department volume and patient complexity. *Am J Emerg Med* 2018;36:366-369. doi:10.1016/j.ajem.2017.08.023
19. Sung CW, Lu TC, Fang CC, et al. Impact of COVID-19 pandemic on emergency department services acuity and possible collateral damage. *Resuscitation* 2020;153:185-186. doi:10.1016/j.resuscitation.2020.06.021
20. Chiu NC, Chi H, Tai YL, et al. Impact of wearing masks, hand hygiene, and social distancing on influenza, enterovirus, and all-cause pneumonia during the coronavirus pandemic: retrospective national epidemiological surveillance study. *J Med Internet Res* 2020;22:e21257. doi:10.2196/21257
21. Zachariasse JM, van der Hagen V, Seiger N, Mackway-Jones K, van Veen M, Moll HA. Performance of triage systems in emergency care: a systematic review and

meta-analysis. *BMJ Open* 2019;9:e026471. doi:10.1136/bmjopen-2018-026471